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U1S S2120

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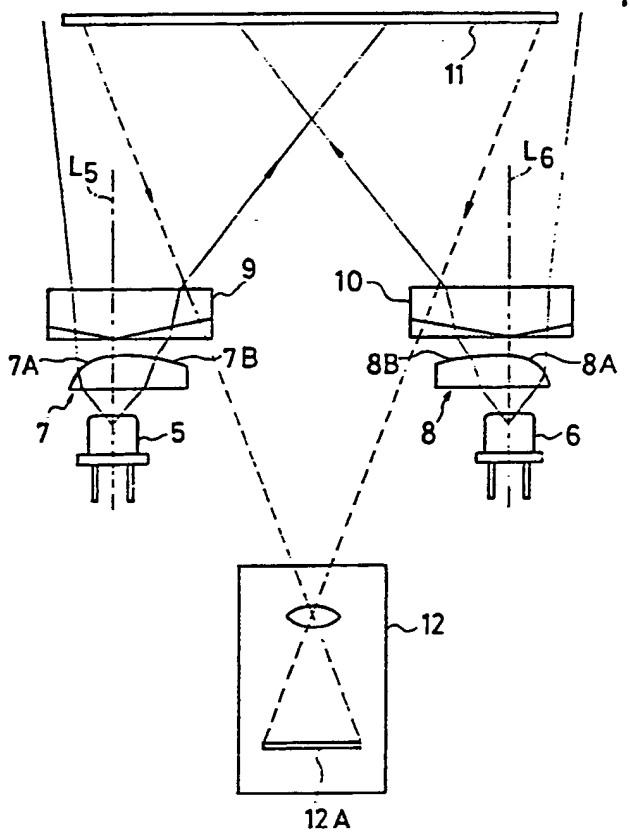
INT CL[4] G06K
Online databases: WPI

(54) Optical bar-code reader

(57) In an optical code reader,the height and width of a light beam emitted by one or more LEDs (5, 6) is varied by two lenses (9, 7; 10, 8) or an integral single lens to produce uniform illumination of a strip-shaped region in which a bar-code is placed in order to be read by a sensor (12A). Suitable lenses are illustrated.

FIG.1



GB 2 225 65!

FIG.1

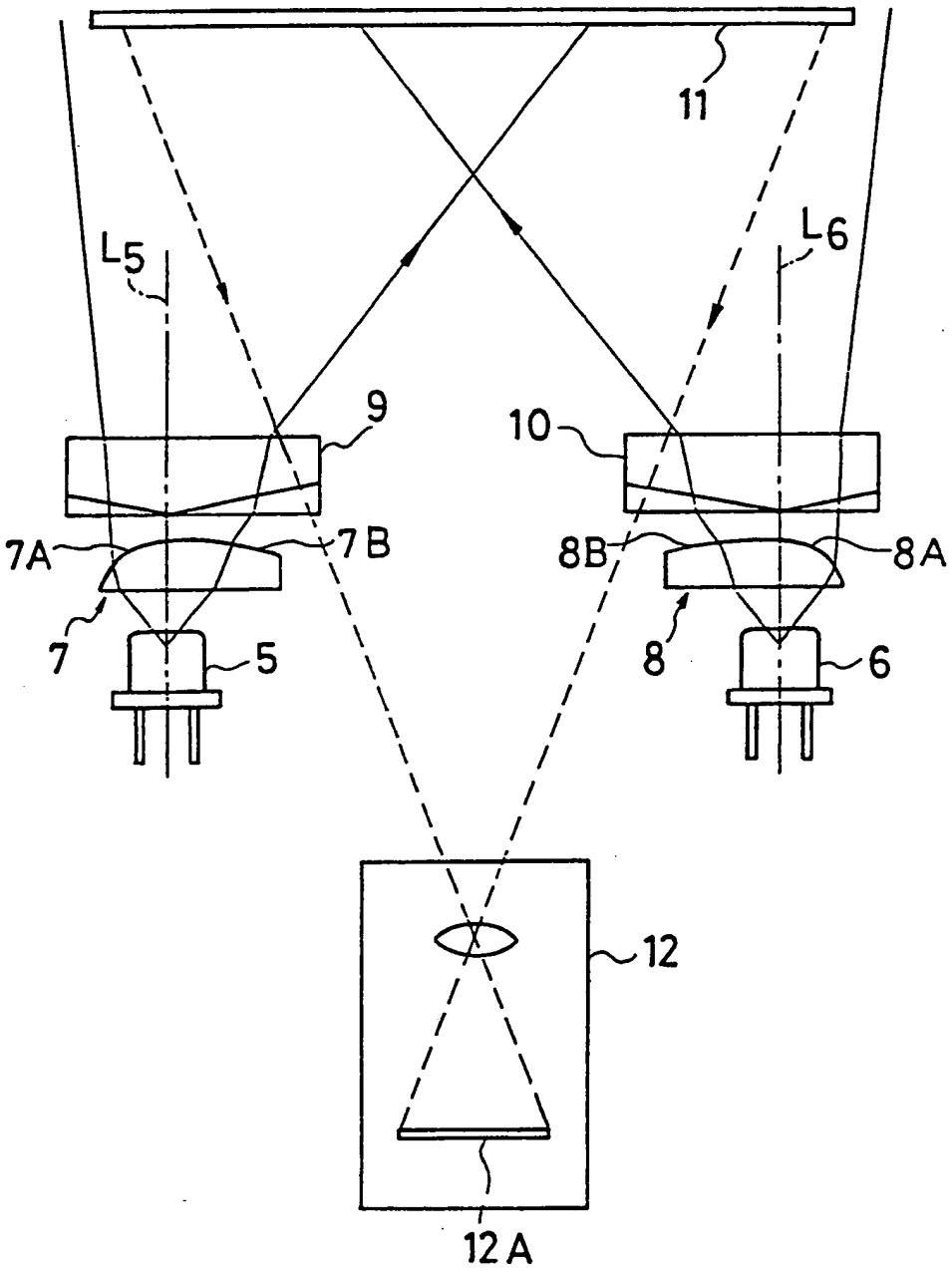


FIG. 2

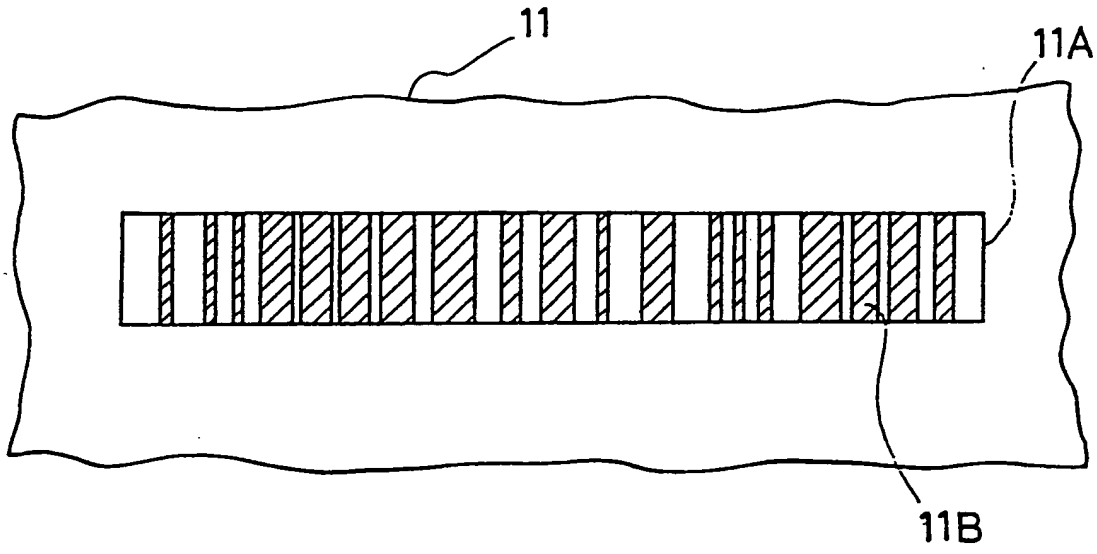


FIG. 3

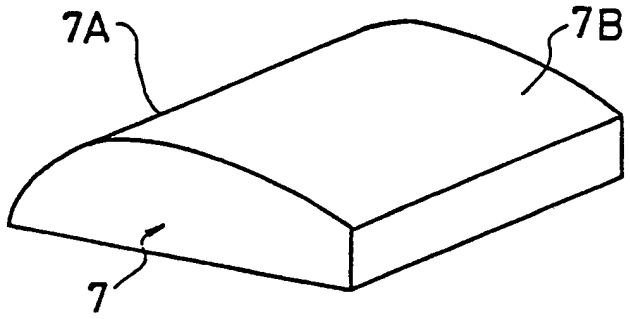

7A
7B
7

FIG. 4

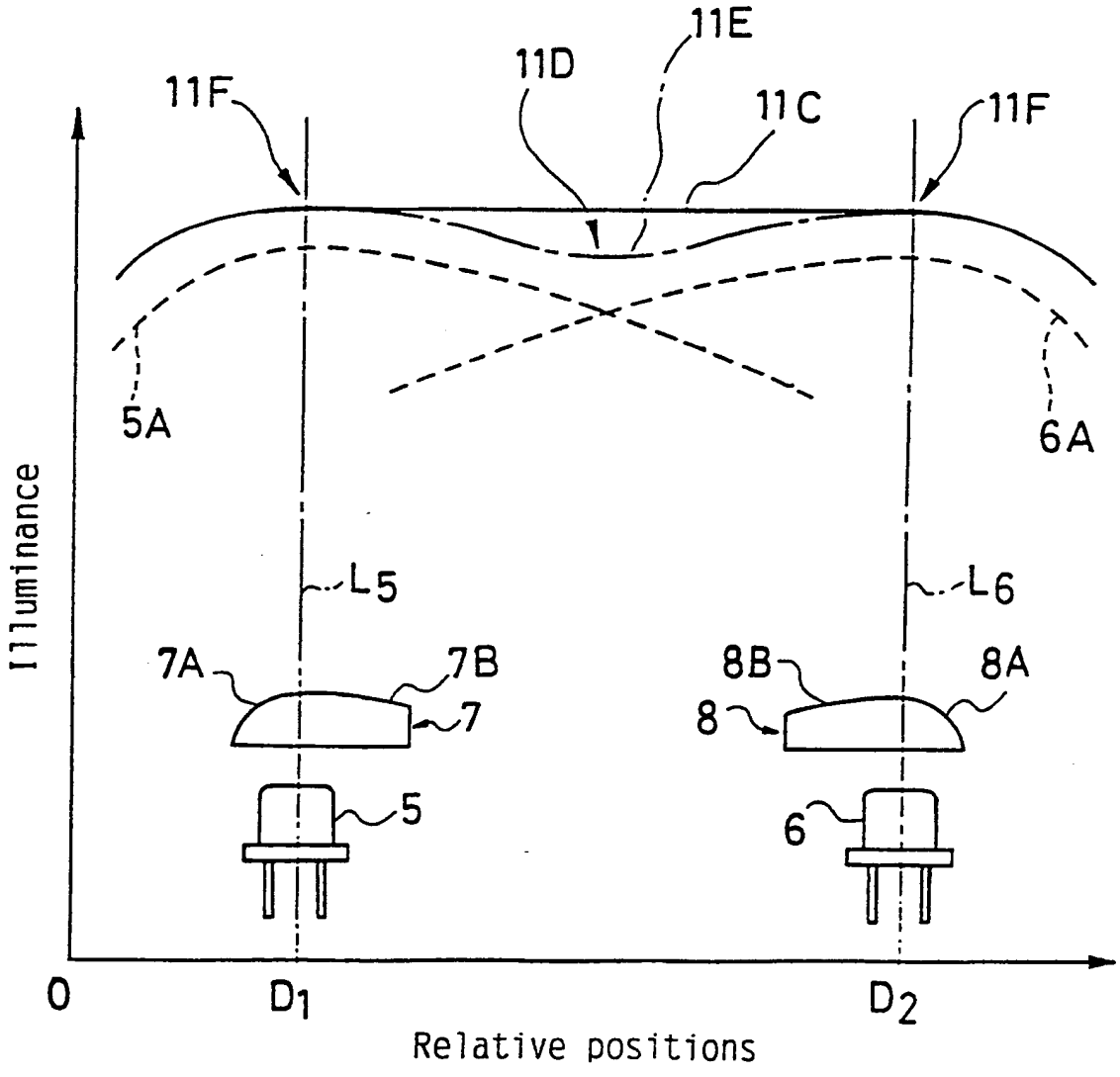

11E
11D
11F
11C
11F
5A
6A
Illuminance
L5
L6
7A
7B
7
8B
8A
8
5
6
0
D1
D2
Relative positions

FIG. 5 (a)

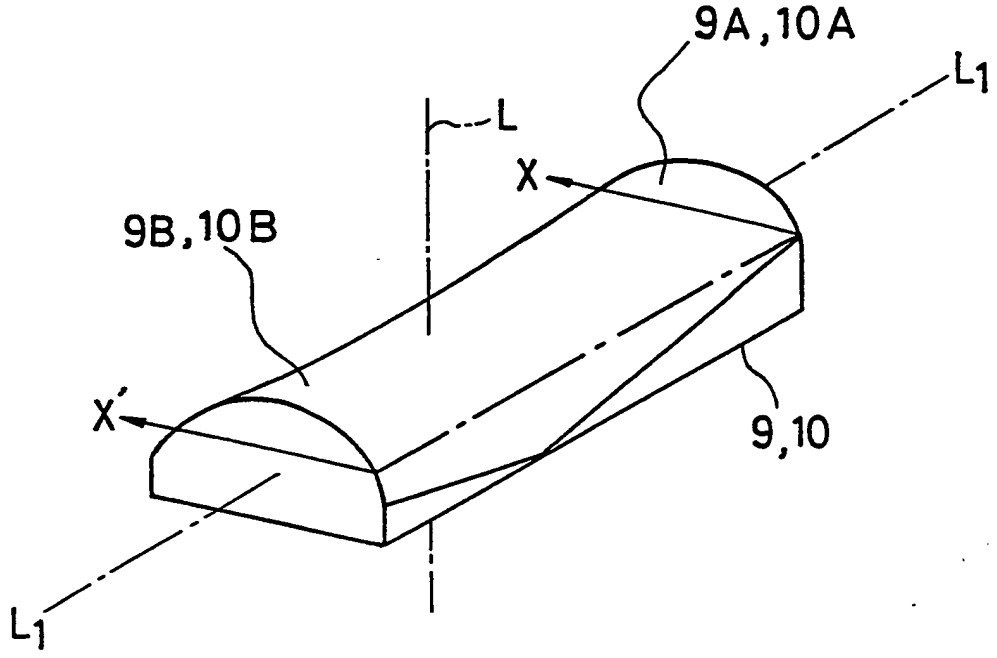


FIG. 5 (b)

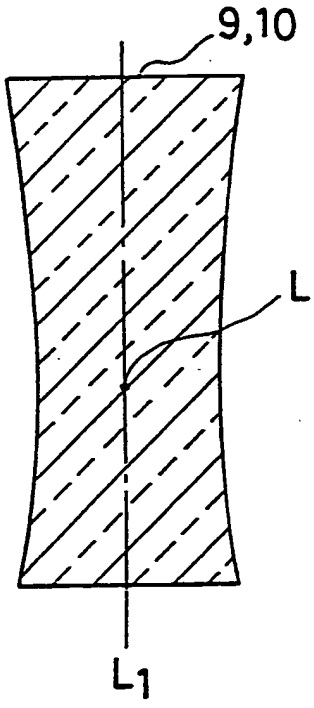


FIG. 5 (c)

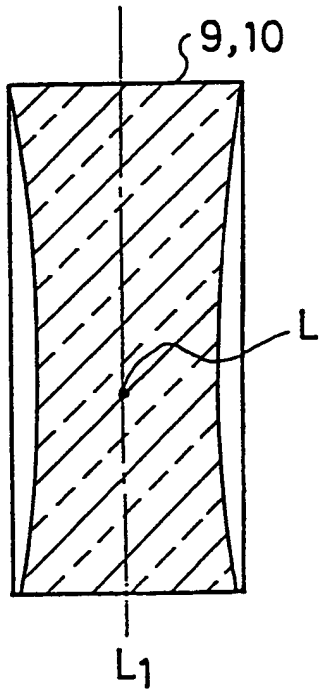


FIG.6

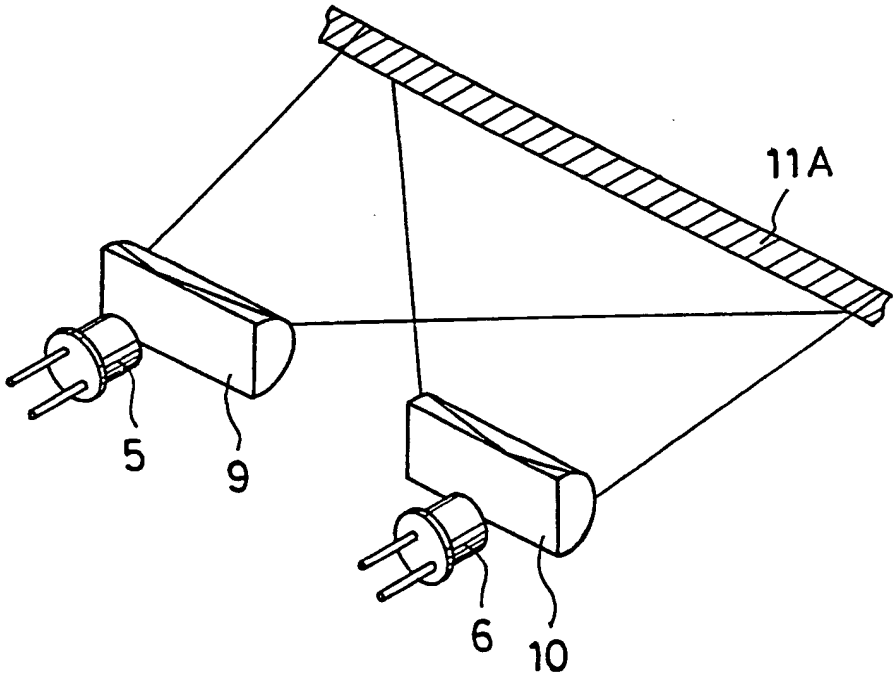


FIG.7 (Comparison Example)

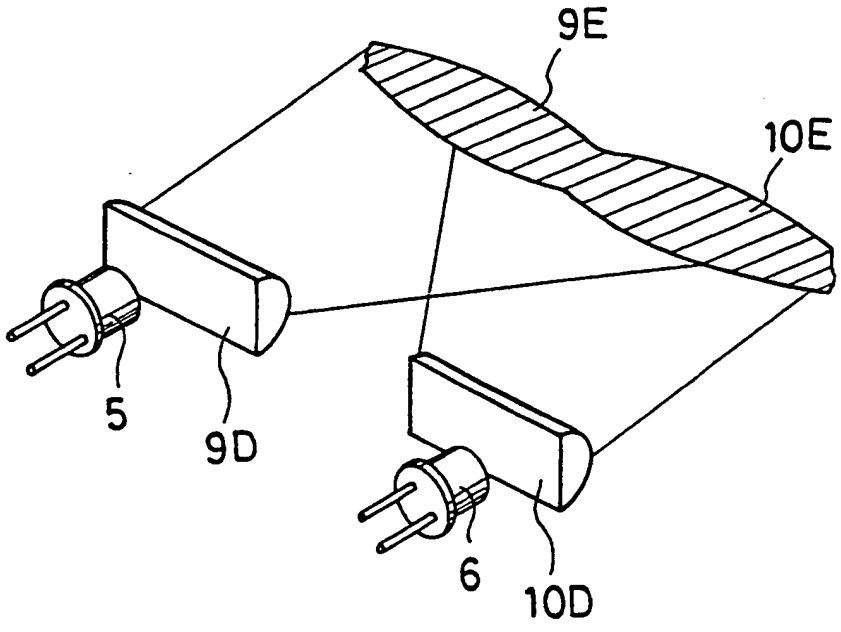


FIG.8

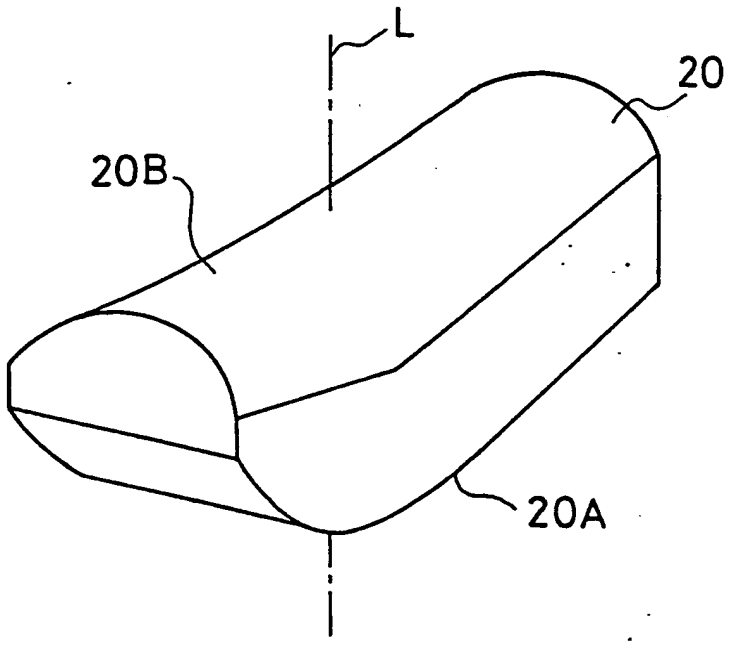


FIG.9

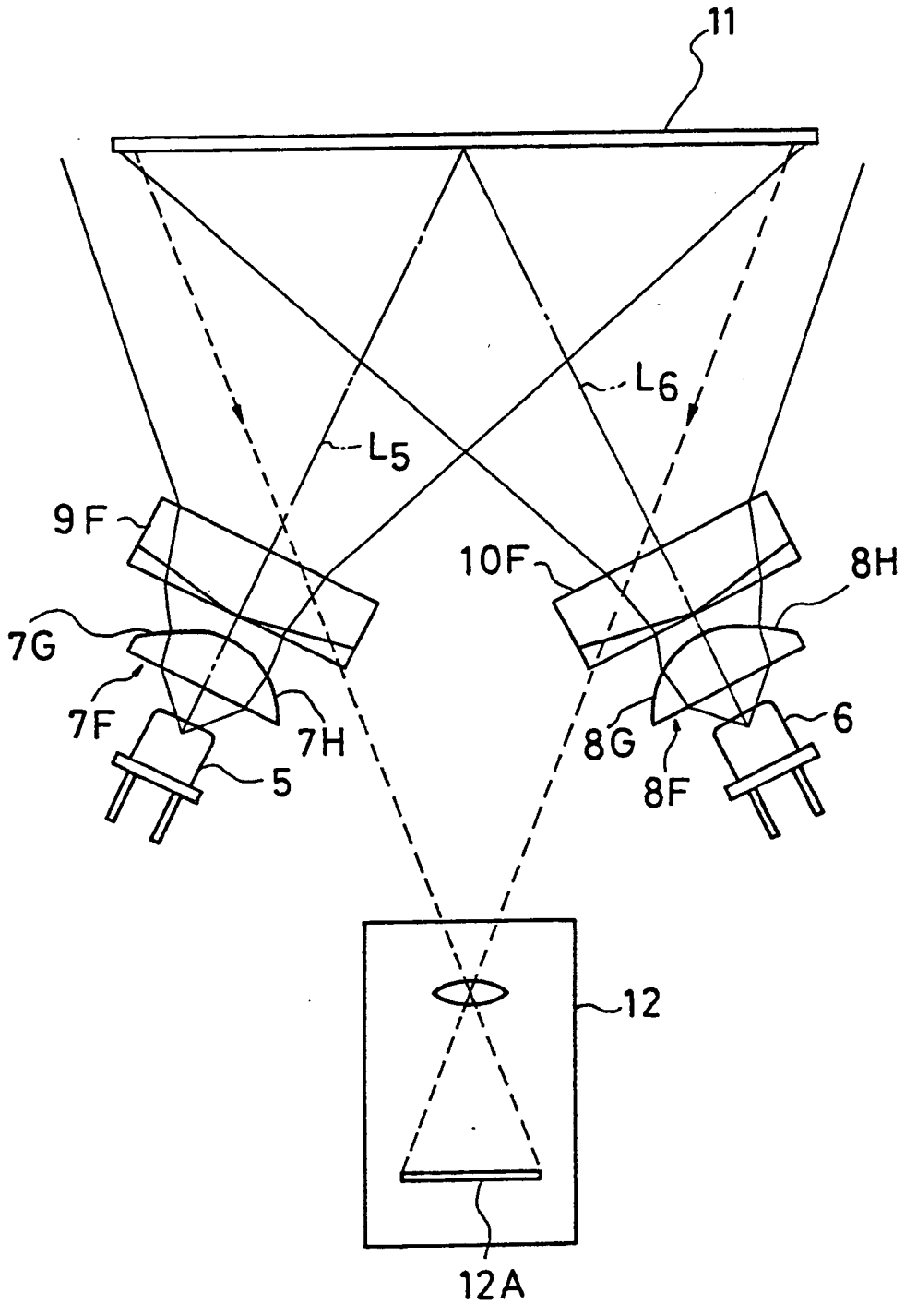


FIG.10(a)

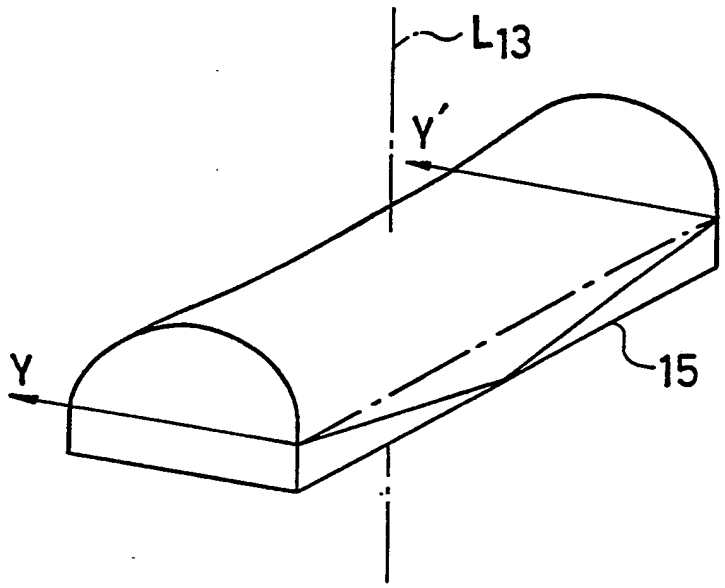


FIG.10(b)

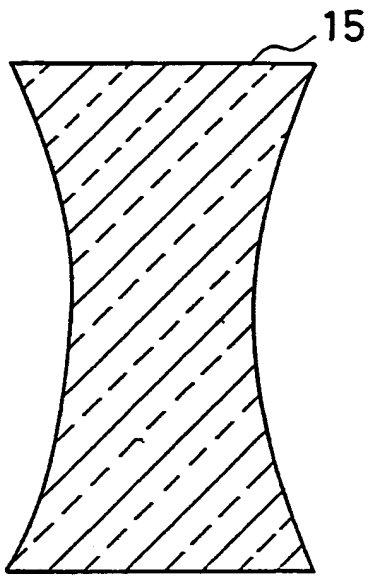


FIG.10(c)

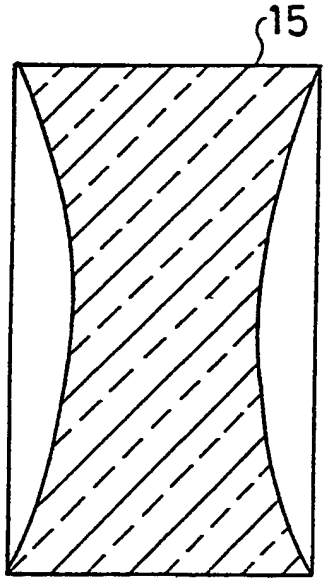


FIG.11(a)

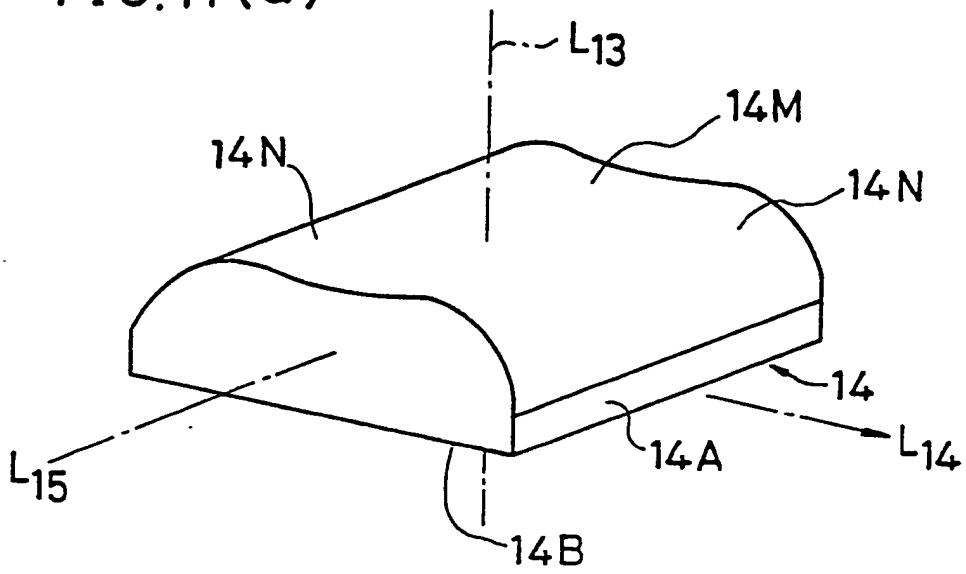


FIG.11(b)

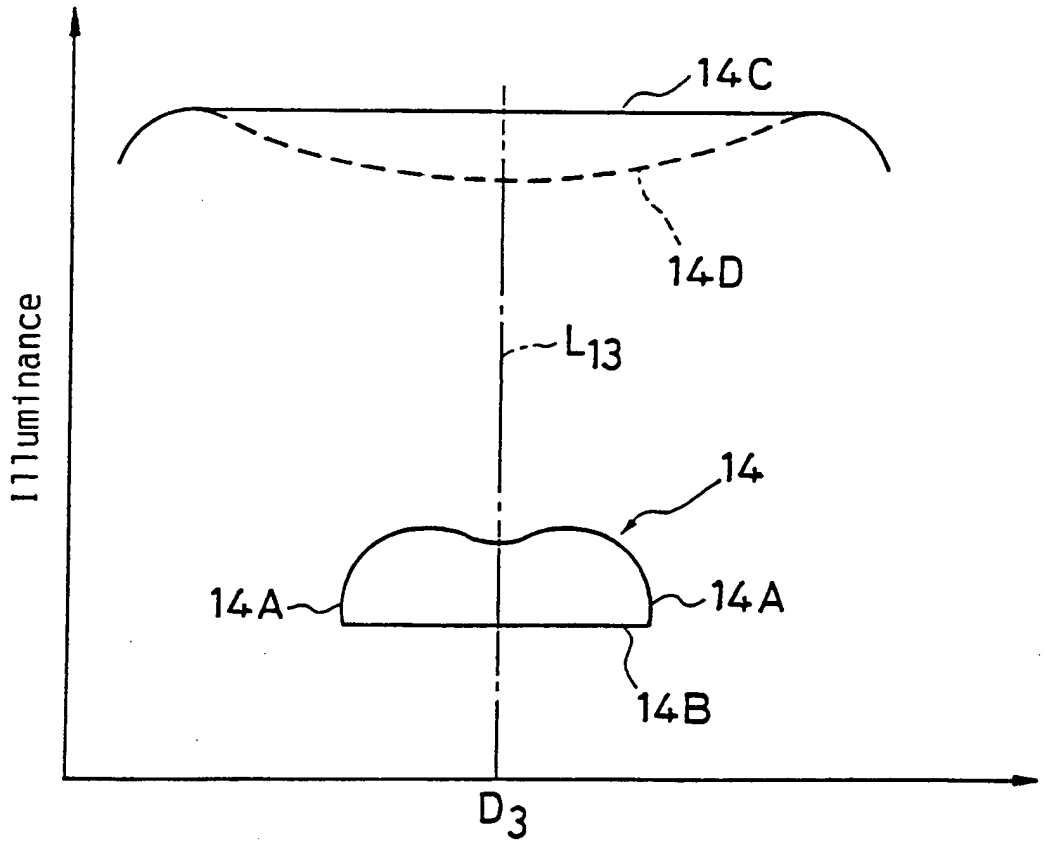


FIG. 12

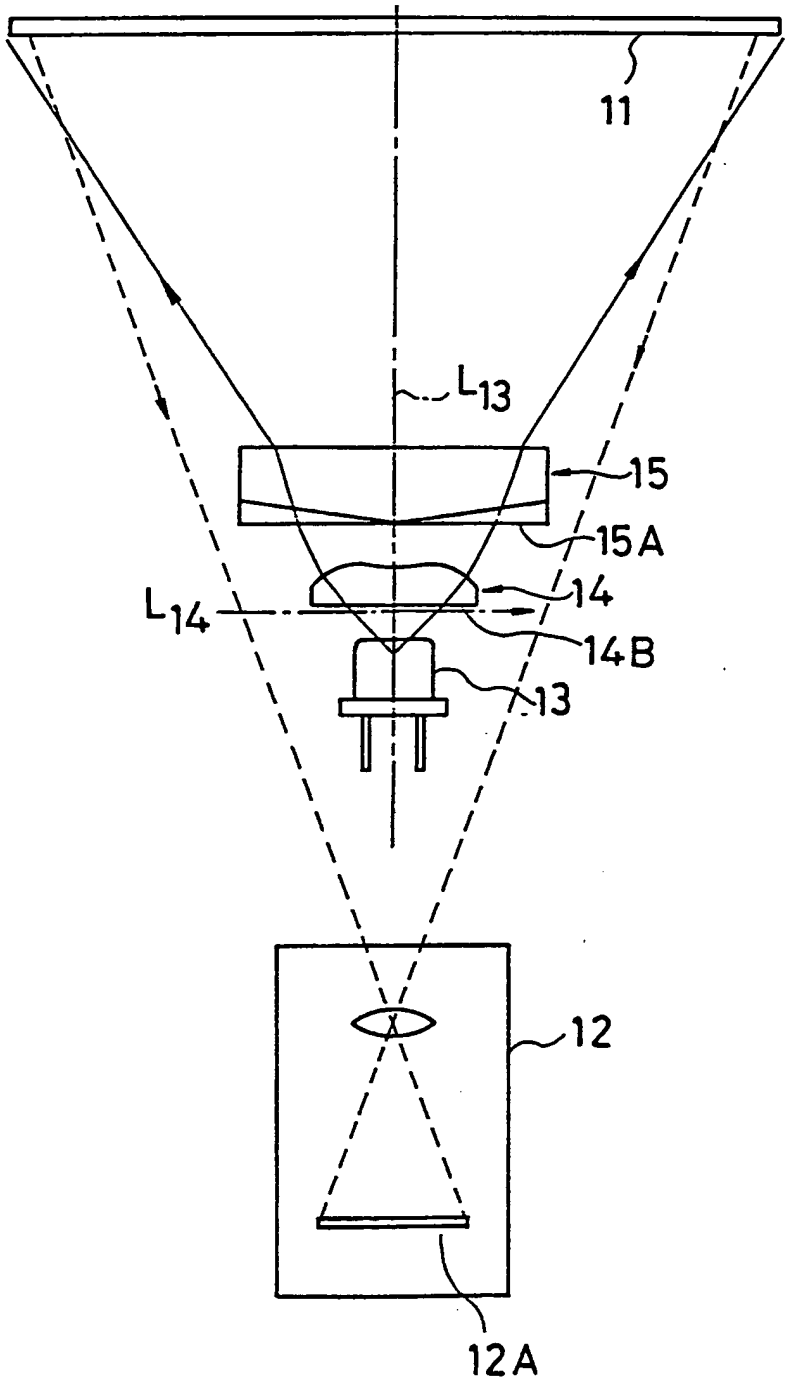


FIG.13(a)(Prior Art)

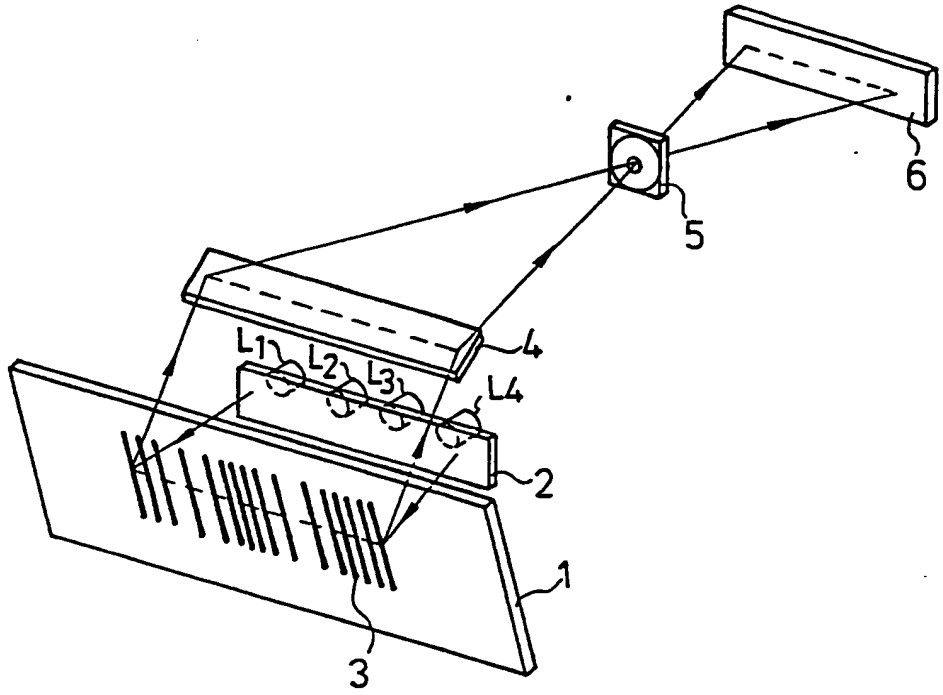
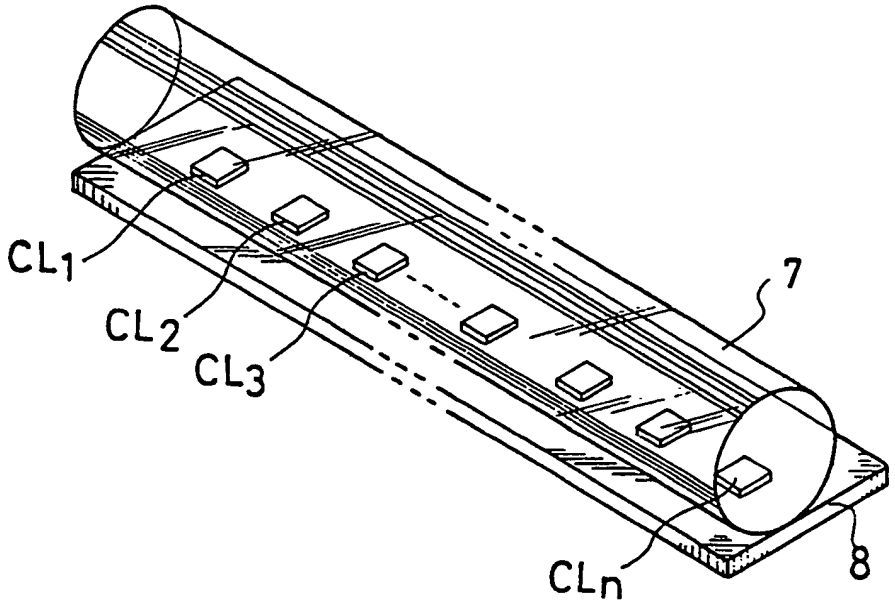


FIG.13(b)(Prior Art)



Optical code reader

The present invention relates generally to an optical code reader, and more particularly to an optical system for converging light radiated from a light source such as a light emitting diode on a surface of an object provided with an optical code.

In an optical code reader such as a bar-code reader using a charge coupled device or an image scanner commonly in use today as a detecting device, an object provided with a bar-code is illuminated with an illuminating means using a light emitting diode (hereinafter is referred to as LED) to emit high luminance red light.

An example of the illuminating means disclosed in Japanese Patent No. 62-17270 is shown in FIG.13(a). Referring to FIG.13(a), four LEDs L_1, L_2, L_3 and L_4 are aligned in a single line, and the light radiated from the LEDs is directed to the surface of the object 1 printed with the bar-code 3 through a light diffusing member 2. Reflected light from the bar-code 3 is focused on an optical line sensor 6 using the charge coupled device via a plane mirror 4 and a lens 5.

Another Prior Art illuminating means is shown in FIG.13(b). Referring to FIG.13(b), a rod lens 7 is placed on a plurality of LED chips CL_1, CL_2 ... CL_n aligned on a substrate 8 and the light beams from the LEDs are focused thereby.

In the illuminating means for the optical code reader, in general, it is necessary to emit sufficiently strong light to eliminate influence due to circumferential light and to realize uniform light distribution on the object. Furthermore, it is experimentally found that the light distribution is preferably higher on both end parts than on a central part of a long and slender illumination area on the object.

In the former prior art shown in FIG.13(a), light required for detection of the bar-code 3 is attained by using plural LEDs, and uniformity in lighting is attained by using the light diffusing member 2. Moreover, the voltage which is applied to the LEDs L_1 and L_4 which are placed on the end parts may be raised enhanced, hence to increase the light on both end parts of the object. However, use of the light diffusing member 2 leads to less light on the object, and light efficiency is reduced. Additionally, assembly work of the many LEDs is troublesome and is expensive in assembly cost.

The latter illuminating means shown in FIG.13(b)

provides the necessary light and uniform light distribution by means of alignment of a large number of the LED chips CL_1 ... CL_n. Moreover, increase of light on the end parts of the object to be illuminated may be attained by increasing the voltage applied to the LED chips CL_1, CL_2, CL_{n-1}, CL_n placed thereon, or by decreasing the interval between the neighbouring two LEDs at the end parts of the illuminating means. In the latter prior art, comparatively uniform light distribution is attainable by adjustment of the light intensity of the respective LEDs provided with voltage adjusting circuits. Hence, manufacturing cost is expensive due not only to the large number of the LEDs but also the respective adjusting circuits.

According to a first aspect of the present invention, an optical code reader comprises at least one light source for emitting a light beam, optical means for converging each light beam in a first direction which is substantially parallel to the lengthwise direction of a strip-shaped region having a predetermined width and wherein an object provided with an optical code may be disposed for reading, and in a second direction which is substantially perpendicular to said first direction and an optical axis passing through the centre of the respective light source, said optical means being disposed between said light source and said region, and optical read means for reading said optical code with a line-sensor.

According to a second aspect of the present invention, an optical code reader comprises at least one light source for emitting a light beam for illuminating an optical code, optical read means for reading said optical code with a line-sensor, and optical means comprising a first optical member for converging each light beam in a first direction which is substantially parallel with the direction of said line sensor and a second optical member for converging said light beam in a second direction which is substantially perpendicular to said first direction and an optical axis passing through the centre of the respective light source, said optical means being disposed between said light source and said optical code.

According to a third aspect of the present invention, an optical code reader comprises two light emitting diodes for emitting light beams, for illuminating an object to be read, optical read means for reading said object with a line-sensor, two first lenses located between said light

emitting diode and said object, for converging respective light beams in a first direction which is substantially parallel with the direction of said line-sensor, and two second lenses located between said light emitting diode and said object for converging respective light beams in a second direction which is substantially perpendicular to said first direction and an optical axis passing through the centre of said light emitting diodes.

According to a fourth aspect of the present invention, an optical code reader comprises a light emitting diode for emitting a light beam for illuminating an object to be read, optical read means having a line-sensor including a row of optical sensors for reading said object, a first lens located between said light emitting diode and said object, for converging said light beam in a first direction which is substantially parallel with the direction of said row, and a second lens located between said light emitting diode and said object, for converging said light beam in a second direction which is substantially perpendicular to said first direction and an optical axis of the light emitting diode.

According to a fifth aspect of the present invention, an optical code reader comprises at least one light source for emitting a light beam for illuminating an optical code, optical read means for reading said optical code with a line-sensor, and optical means comprising a first optical member for converging each light beam in a first direction which is substantially parallel to the direction of said line sensor and a second optical member for converging said light beam in a second direction which is perpendicular to said first direction and an optical axis passing through the centre of said light sources, said optical means being placed between said light sources and said optical code.

The invention will now be described by way of non-limiting examples with reference to the accompanying drawings, in which:-

FIG. 1 is a plan view of a first embodiment of an optical system of the optical code reader in accordance with the present invention;

FIG. 2 is a front view of a strip-shaped illuminating area on an object provided with a bar-code;

FIG. 3 is a perspective view of a first lens in the optical system;

FIG. 4 is a graph of light distribution by means of the optical system of the first embodiment;

FIG. 5(a) is a perspective view of a second lens in the optical system;

FIGs.5(b) and 5(c) are cross sectional views of the second lens;

FIG.6 is a perspective view of the optical system of the first embodiment;

FIG.7 is a perspective view of an optical system using other type of a second lens;

FIG.8 is a perspective view of an embodiment of the lens in the optical system;

FIG.9 is a plan view of a second embodiment of an optical system of the optical code reader in accordance with the present invention;

FIG.10(a) is a perspective view of a second lens in the second and third embodiments;

FIGs. 10(b) and 10(c) are cross sectioned views of the second lens;

FIG.11(a) is a perspective view of a first lens in the second embodiment;

FIG.11(b) is a graph of illuminance distribution in the third embodiment;

FIG.12 is a plan view of a third embodiment of an optical system of the optical code reader in accordance with the present invention;

FIG.13(a) is the perspective view of the optical system in the prior art;

FIG.13(b) is the perspective view of another optical system in the prior art.

FIG.1 is a plan view of a first embodiment of the optical code reader in accordance with the present invention. Two LEDs 5 and 6 are positioned spaced apart and face an object 11 provided with a bar-code, for example. First lenses 7 and 8 are located in front of the LEDs 5 and 6, respectively, and furthermore, second lenses 9 and 10 are located in front of the first lenses 7 and 8, respectively. The object 11 to be read is placed at a predetermined position which is apart from the second lenses 9 and 10 and is illuminated by the light emitted from the LEDs 5 and 6. As shown in FIG.2, the object 11 has a strip-shaped code area 11A on which the bar-code 11B is printed, for example. The bar-code 11B is read by an optical read means 12 having a line sensor 12A (FIG.1) which comprises a row of a large number of optical sensors. The strip-shaped code area 11A is required to be uniformly illuminated.

FIG.3 is a perspective view of the first lens 7. Another first lens 8 is configurated similarly but in symmetry to the first lens 7. The lens 7 has a relatively small curvature radius at an outside part 7A, and a relatively large curvature radius at an inside part 7B. As shown in FIG.1, the parts 7B and 8B are located inside a region which is between both optical axes L5 and L6 of the LEDs 5 and 6. Conversely, the parts 7A and 8A are located

outside thereof. The line sensor 12A is disposed parallel to a line connecting both the LEDs 5 and 6.

FIG.4 is a graph of light distribution on the object 11 on which the light beams emitted from the two LEDs 5 and 6 are converged with the respective first lenses 7 and 8. Abscissa designates relative positions, and ordinate designates light on the object 11. The LEDs 5 and 6 are located at positions D1 and D2, respectively. Referring to the graph, broken lines 5A and 6A represent the light of LEDs 5 and 6. Hence, light on the object 11 results in substantial uniformity of illumination as shown by a solid line 11C in the region between the positions D1 and D2.

In the first embodiment, light on the central part 11D can be reduced by changing the curvature radius of the parts 7B and 8B of the first lenses 7 and 8, as shown by an alternate long and short dash line 11E. According to this light distribution, the light is relatively enhanced at both end parts 11F, as a result of slight light reduction at the central part 11D.

FIG.5(a) is a perspective view of the second lens 9 or 10, and FIGs.5(b) and 5(c) are horizontal sections of FIG.5(a) taken along the line X-X'. An alternate long and short dash line L designates the optical axis of the light beam emitted from the LED 5 or

6. Th second lens 9 or 10 is semicylinder-shaped, and the curvature radius of the upper part is varied along the length. The curvature radius is smallest on the part adjacent to the optical axis L, and gradually increases toward both ends. The optical axis L is not on the center of the second lens 9 or 10, but is displaced a predetermined distance from the center on a horizontal axis L1 along the length thereof. A variation ratio of the curvature radius on the longer part 9A or 10A with respect to the optical axis L is selected to be larger than that of the shorter part 9B or 10B. In assembly of the optical code reader, the longer sides 9A and 10A are disposed inside and hence the shorter sides 9B and 10B are disposed outside. The second lenses 9 and 10 are located in a manner that the common axis L1 (FIG.5(b) and FIG.5(c)) which is along the length of the second lenses 9 and 10 is included in a plane in which the axes L5 and L6 are included, and the common axis is disposed parallel to the line sensor 12A. The optical axes L of the second lens 9 and 10 are in coincidence with the optical axes L5 and L6 of the first lenses 7 and 8, respectively as shown in FIG.1. Thus, the light beams radiated from the LEDs 5 and 6 are converged with respect to the perpendicular direction of the paper surface by the second lens 9 or 10, and consequently the light beam is converged on a strip-shaped area 11A having a predetermined width as shown in

FIG.6.

FIG.7 is a perspective view of an optical system using semicylinder-shaped lenses 9D and 10D, for example. In this case, the light beams radiated from the LEDs 5 and 6 are converged on barrel-shaped areas 9E and 10E instead of the strip-shaped area shown in FIG.6. In the general optical code reader, the strip-shaped area is preferable to the barrel-shaped area.

FIG.8 is a perspective view of a lens 20 in an embodiment of the lens in the optical system of the optical reader. In this embodiment, the first lens 7 or 8 of FIG.6 or FIG.7 is combined integral with the second lens 9 or 10 to form the lens 20. Referring to FIG.8, a lower part 20A of the lens 20 functions as the first lens 7 or 8, and an upper part 20B functions as the second lens 9 or 10.

FIG.9 is a plan view of another embodiment of an optical system of the optical code reader in accordance with the present invention. In this embodiment, the left optical system composed of the LED 5, a first lens 7F and a second lens 9F is inclined in a manner that the optical axis L5 passes through the center of the object 11; and the right optical system composed of the LED 6, a first lens 8F and a second lens 10F is also inclined in the same manner as the left optical system. The first lens 7F has a small difference between the curvature radiuses of parts

7G and 7H. The first lens 8F is symmetrical to the first lens 7F.

The curvature radius of the semicylindrical upper part of the second lens 9F or 10F is smallest at the center, and gradually increases toward both ends as shown in FIG.10(a).

According to the second embodiment, since the object 11 is illuminated by both the LED 5 and 6, if either one of the LEDs 5 and 6 malfunctions, or if the light path of either optical system is intercepted by something for some reason, the whole bar-code area of the object 11 remains illuminated by the other LED.

FIG.12 is a plan view of a third embodiment of the optical system of the optical code reader in accordance with the present invention. In this embodiment, a light beam emitted from a LED 13 is converged on the object 11 by a first lens 14 and a second lens 15 positioned in front of the LED 13 in the named order. The first lens 14 is an irregular semicylindrical member which is concaved on a central part 14M along the length thereof as shown in FIG.11(a). The curvature radius of convex parts 14N gradually decreases toward both side walls 14A which are vertical plane surfaces. The first lens 14 is arranged in a manner that an axis L14 (FIG. 11(a)) which is substantially perpendicular to the side

walls 14A is parallel to the length of the object 11 and the line sensor 12A of the optical read means 12. The second lens 15 is similar to the second lens 9F or 10F in the second embodiment.

FIG.11(b) is a graph of light distribution along the length of the object 11 in the third embodiment. Referring to the graph, a solid line 14C designates light distribution in this embodiment. If desired, illumination at the end parts of the object 11 may be relatively enhanced as designated by a dashed line 14D by changing the curvature radius of the concave part 14M. In this embodiment, the light beam emitted from the LED 13 is also converged into a strip-shaped area having a predetermined width on the object 11.

Furthermore, the first lens 14 can be combined with the second lens 15 in a manner that the surface 14B of the first lens 14 is joined to the surface 15A of the second lens 15 in one body.

In the optical code readers of the above embodiments, the light beam emitted from the LED is focussed in two directions: one is parallel to the length of the object 11, and the other is perpendicular to both the length of the object 11 and the optical axis L of the optical system. Thus, the light emitted from the LED is effectively available for illuminating the object. Hence, sufficient light

on the object is obtained by using one or two LEDs. Furthermore, assembly work of the LED is simplified because of the small number of LEDs, and thus the assembly cost of the optical code reader is reduced.

CLAIMS

1. An optical code reader comprising:

at least one light source for emitting a light beam,

optical means for converging each light beam in a first direction which is substantially parallel to the lengthwise direction of a strip-shaped region having a predetermined width and wherein an object provided with an optical code may be disposed for reading, and in a second direction which is substantially perpendicular to said first direction and an optical axis passing through the centre of the respective light source, said optical means being disposed between said light source and said region, and

optical read means for reading said optical code with a line-sensor.

2. An optical code reader comprising:

at least one light source for emitting a light beam for illuminating an optical code,

optical read means for reading said optical code with a line-sensor, and

optical means comprising a first optical member for converging each light beam in a first direction which is substantially parallel with the direction of said line sensor and a second optical member for converging said light beam in a second direction which is substantially perpendicular to said first direction and an optical axis passing through the centre of the respective light source, said optical means being disposed between said light source and said optical code.

3. An optical code reader comprising:

two light emitting diodes for emitting light beams, for illuminating an object to be read,

optical read means for reading said object with a line-sensor,

two first lenses located between said light emitting diode and said object, for converging respective light beams in a first direction which is substantially parallel with the direction of said line-sensor, and

two second lenses located between said light emitting diode and said object for converging respective light beams in a second direction which is substantially perpendicular to said first direction and an optical axis passing through the centre of said light emitting diodes.

4. An optical code reader in accordance with claim 3, wherein each first lens is curved in said first direction, and the radius of curvature varies and is greater on the part of the lens in the zone between the optical axes of the two light emitting diodes than it is on the part of the lens outside said zone.

5. An optical code reader in accordance with claim 3 or claim 4, wherein each second lens is curved in said second direction, and the radius of curvature varies and is smaller on the part of the lens adjacent the optical axis of the lens than it is on the parts of the lens at both ends thereof.

6. An optical code reader in accordance with claim 3, 4 or 5, wherein each first lens is integral with the respective one of said second lenses converging the same light beam.

7. An optical code reader comprising:

a light emitting diode for emitting a light beam for illuminating an object to be read,

optical read means having a line-sensor including a row of optical sensors for reading said object,

a first lens located between said light emitting diode and said object, for converging said light beam in a first direction which is substantially parallel with the direction of said row, and

a second lens located between said light emitting diode and said object, for converging said light beam in a second direction which is substantially perpendicular to said first direction and an optical axis of the light mitting diode.

8. An optical code reader comprising:

at least one light source for emitting a light beam for illuminating an optical code,

optical read means for reading said optical code with a line-sensor, and

optical means comprising a first optical member for converging each light beam in a first direction which is substantially parallel to the direction of said line sensor and a second optical member for converging said light beam in a second direction which is perpendicular to said first direction and an optical axis passing through the centre of said light sources, said optical means being placed between said light sources and said optical code.

9. An optical code reader in accordance with claim 7, wherein said first lens is curved in said first direction, and the radius of curvature varies and is substantially symmetrical with respect to a centre line parallel with said second direction and gradually decreases toward the ends of the lens.

10. An optical code reader in accordance with claim 7 or 9, wherein said second lens is curved in said second direction, and the radius of curvature varies and is smaller at adjacent the optical axis of the lens than it is at the ends thereof.

11. An optical code reader in accordance with claim 7, 9 or 10, wherein said first lens is integral with said second lens.

12. An optical code reader substantially as herein described with reference to Figures 1 to 12 of the accompanying drawings.

13. All novel features and combinations thereof.